COSEWIC
Assessment and Status Report

on the

Swift Fox
Vulpes velox

in Canada

THREATENED
2009

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada

COSEPAC
Comité sur la situation
des espèces en péril
au Canada

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Carbyn, L.N. 1998. Update COSEWIC status report on the Swift Fox *Vulpes velox* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 1-44 pp.

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COSEWIC
Assessment Summary

Assessment Summary – November 2009

Common name
Swift Fox

Scientific name
Vulpes velox

Status
Threatened

Reason for designation
This species was extirpated from Canada in the 1930s. Following reintroduction programs in Alberta and Saskatchewan initiated in 1983, they have re-established populations in these areas and in northern Montana. Population numbers and distribution have increased since that time, with the current estimate in Canada having doubled to 647 since the last COSEWIC assessment in 2000. Connectivity between populations has also improved during this time, particularly through northern Montana. Since 2001, population numbers and distribution have remained stable and habitat for this species within Canada appears to be saturated. Most improvement in overall population status can be attributed to populations in Montana, which are still demonstrating increasing trends in numbers and distribution. Deteriorating habitat in Canada and the threat of disease (as seen in other canids) could threaten the continued recovery of this species.

Occurrence
Alberta, Saskatchewan

Status history
Last seen in Saskatchewan in 1928. Designated Extirpated in April 1978. Status re-examined and designated Endangered in April 1998 after successful re-introductions. Status re-examined and confirmed in May 2000. Status re-examined and designated Threatened in November 2009.

COSEWIC
Executive Summary

Swift Fox
Vulpes velox

Species information

Standing 30–32 cm at the shoulder with a body mass of 1.6–3.0 kg, the Swift Fox (*Vulpes velox*) is North America's smallest canid. Males are slightly larger than females. The fur is long and dense in winter. The upper parts are generally dark buffy-grey, the sides, legs, and beneath the tail are orange-tan, and the undersides are buff to pure white. In summer, the fur is shorter and more rufous. Swift Foxes have black patches on either side of their muzzles and black-tipped tails.

Distribution

The historic range of Swift Foxes extended from central Alberta, south to central Texas, and from North Dakota, west to central Colorado. In Canada, they originally occurred from the Pembina Hills in Manitoba, across southern Saskatchewan, and west to the foothills of the Rocky Mountains in Alberta. Having disappeared from Canada by the 1930s their current presence on the Canadian prairies is a result of a reintroduction program initiated in 1983. Most Swift Foxes currently occur in the southernmost portion of the prairies near the Alberta-Saskatchewan border, in and around Grasslands National Park in south-central Saskatchewan.

Habitat

Swift Foxes generally inhabit short- or mixed-grass prairie on level terrain or gently rolling hills. They usually select areas with short, sparse vegetation and topographic features like canyons, steep hills, or coulees. The quality of Swift Fox habitat is related to prey availability (particularly fossorial mammals) and predator abundance. They prefer relatively dry areas, and avoid cropland, fragmented habitats, and those with large elevation changes. Swift Fox range encompasses some of the most modified landscapes in North America, and conversion of native prairie to agriculture has been implicated as a primary reason for the historical range contraction of this species. Current estimates indicate that only 25–30% of original Canadian grassland habitat remains, and that at least 70% of native Canadian prairie has been converted for agricultural use. Energy development and associated road networks are currently the dominant agent of land use change.

Biology

Swift Foxes are opportunistic foragers that eat mammals, birds, insects, plants, and carrion, as well as bird eggs. Diet reflects the diversity and abundance of local prey species, and is highly seasonal. Swift Foxes either dig their own dens or modify those of other species. They are one of the most burrow-dependent canids, using dens throughout the year as refugia from predators, protection from extreme weather, shelter to prevent excess water loss, periodic resting cover, and as places to raise young. In Canada, Swift Foxes begin breeding in mid-February, and after a 51-day gestation, females have litters of 2–6 kits. Kits disperse between 9.5 and 18 months of age over distances typically less than 15 km from the natal area. Swift Foxes that survive their first year usually live for 3–7 years. They are territorial, with home ranges averaging 32 km^2 in size - larger than they are within core Swift Fox range, reflecting the more marginal habitat at the range periphery. Coyotes (*Canis latrans*) are the primary predator, followed by Golden Eagles (*Aquila chrysaetos*), and American Badgers (*Taxidea taxus*).

Population sizes and trends

The most recent population estimates in Canada indicate there are approximately 647 Swift Foxes in Canada, divided between the Alberta-Saskatchewan border (Border) population (513) and the Grasslands National Park (GNP) population (134). Over time, the populations from these two original reintroduction sites have become one meta-population, together with northern Montana, with evidence of long-distance dispersal throughout. Overall, Swift Fox populations in Canada increased by 130% between 1996 to 2006, although these estimates are overly precise because there are no confidence limits associated with these data. Swift Fox population density in Canada (Border and GNP populations only) is about 5.5 foxes/100 km^2, and the sex ratio is 52 males:48 females.

Limiting Factors and Threats

The primary well-documented natural factor limiting Swift Fox abundance and distribution in Canada is predation by Coyotes and Golden Eagles. Habitat loss, degradation and disturbance from development activities is a growing concern within Swift Fox range. Although there is no evidence to date that disease has caused significant Swift Fox mortality, the potential exists, in light of high seroprevalence to several diseases, the small and connected population, and the well-recorded incidence of disease having suddenly decimated other endangered canid populations. Competition with Coyotes and Red Foxes (*Vulpes vulpes*) are an additional potential limiting factor. Other threats to Swift Foxes in Canada include poisoning, trapping, and vehicle collisions.

Special significance of the species

Able to run at speeds of up to 60 km/h, Swift Foxes are one of the fastest animals in North America. As meso-predators, they are important to the biodiversity of the Canadian prairies. Swift Foxes also play a vital role in the spirituality of some of Canada's First Nation cultures.

Existing protection

Globally, the Swift Fox is ranked as Least Concern by the *International Union for Conservation of Nature* [*IUCN*] *Red List of Threatened Species*. In May 2000, COSEWIC assessed the Swift Fox as Endangered. Currently, the Swift Fox is listed on Schedule 1 of the *Species at Risk Act*. Provincially, Swift Foxes are listed as Endangered under the *Alberta Wildlife Act and Regulation* and the *Saskatchewan Wildlife Habitat Protection Act*. About 45% of Swift Fox captures during the 2005–2006 census were located within one Swift Fox home range on federal lands under various levels of protection.

COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS
(2009)

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

** Formerly described as "Not In Any Category", or "No Designation Required."

*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.

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Canada

The Canadian Wildlife Service, Environment Canada, provides full administrative and financial support to the COSEWIC Secretariat.

COSEWIC Status Report

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Swift Fox

Vulpes velox

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2009

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SPECIES INFORMATION

Name and classification

Scientific name:	*Vulpes velox*, Say 1823
English name:	Swift Fox
French name:	Renard véloce
Aboriginal names:	Senopah (Blackfeet Tribe), Sinopaa (Blood Tribe)
Classification:	Class – Mammalia
	Order – Carnivora
	Family – Canidae
	Genus – Vulpes
	Species – *Vulpes velox*

First described by Say (1823) as *Canis velox* (see Thwaites 1905), Swift Foxes were re-assigned to the genus *Vulpes* by Audubon and Bachman (1851). Swift Foxes and Kit Foxes (*V. macrotis*) are similar in appearance and Hall (1981) and Dragoo *et al.* (1990) suggested they were conspecific based on morphometric similarities and protein-electrophoresis. However, Mercure *et al.* (1993) demonstrated through mitochondrial DNA analyses that the sequence divergence between the two species is similar to that between other morphologically distinct canids - a conclusion that was supported by other morphometric analyses (Stromberg and Boyce 1986). Other than one narrow zone in eastern New Mexico and western Texas, where their ranges meet (Rohwer and Kilgore 1973), the topographic barrier of the Rocky Mountains separates the distributions of Kit and Swift Foxes. Although there has been known hybridization between the two species in this limited area, Thornton and Creel (1975) found the offspring to be of reduced viability. Merriam (1902) gave subspecific designations of *V. velox hebes* (northern Swift Fox; Canada and northern United States [US]) and *V. velox velox* (southern Swift Fox; southern range in US). Despite significant geographic variation in morphology within the species, however, these subspecific assignments are not likely valid (Stromberg and Boyce 1986).

Morphological description

Swift Fox are the smallest North American canid, measuring just 70–88 cm in length (including the tail), standing 30–32 cm at the shoulder, and with a body mass of 1.6–3.0 kg (Kilgore 1969; Thornton and Creel 1975; Egoscue 1979; Harrison 2003) (Figure 1). On average, males are 8% larger than females (Egoscue 1979). Winter pelage is long and dense, with dark buffy-grey upper parts, orange-tan sides, legs, and ventral surface of the tail, with buff to pure white fur underneath; whereas summer pelage is shorter and more rufous (Nowak 1999). Swift Foxes have black patches on either side of the muzzle and a black-tipped tail. They do not exhibit sexual colour dimorphism (Chambers 1978). Unlike Red Foxes (*Vulpes vulpes*) and Arctic Foxes (*V. lagopus*), Swift Foxes in Canada are not known to exhibit distinct colour phases (Underwood and Mosher 1982; Cypher 2003).

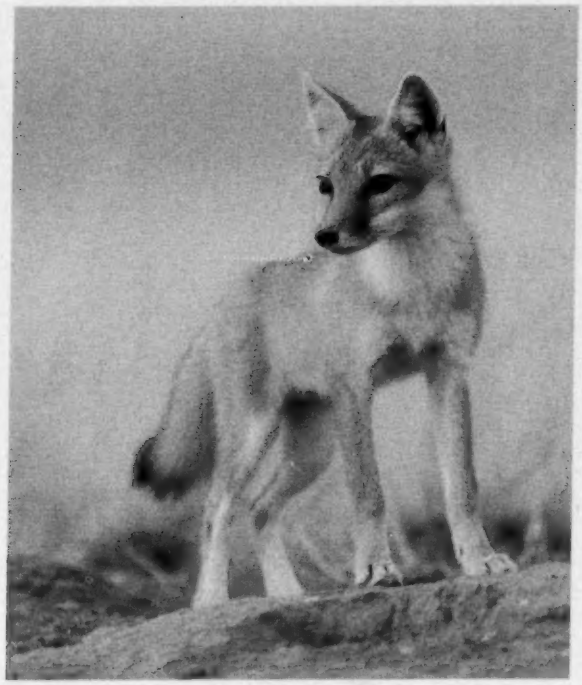

Figure 1. Adult Swift Fox (Photo © Gordon Court 2009).

Genetic description

See discussion in **Name and classification** section on genetic and other information that serves to distinguish Swift foxes from Kit Foxes. Extensive genetic evidence suggests that apart from Kit Foxes, the closest relative to Swift Foxes are Arctic Foxes (e.g., Wayne and O'Brien 1987; Geffen *et al.* 1992; Mercure *et al.* 1993; Bininda-Emonds *et al.* 1999; Zrzavý and Řičánková 2004; Bardeleben *et al.* 2005).

Designatable units

There are no known distinctions between populations within the species that would warrant consideration of separate designatable units. This report is therefore based on a single designatable unit of *Vulpes velox*.

DISTRIBUTION

Global range

Historically, Swift Foxes occurred in mixed- or short-grass prairie from central Alberta, south to central Texas and from North Dakota, west to central Colorado (Allardyce and Sovada 2003; Figure 2) – an estimated range of approximately 1.6 million km^2 (Scott-Brown *et al.* 1987). The most dramatic reductions in the range of the Swift Fox occurred in the early 1800s to the mid 1900s; in the United States, the current range is believed to be about 40% of its historic range (Kahn *et al.* 1997).

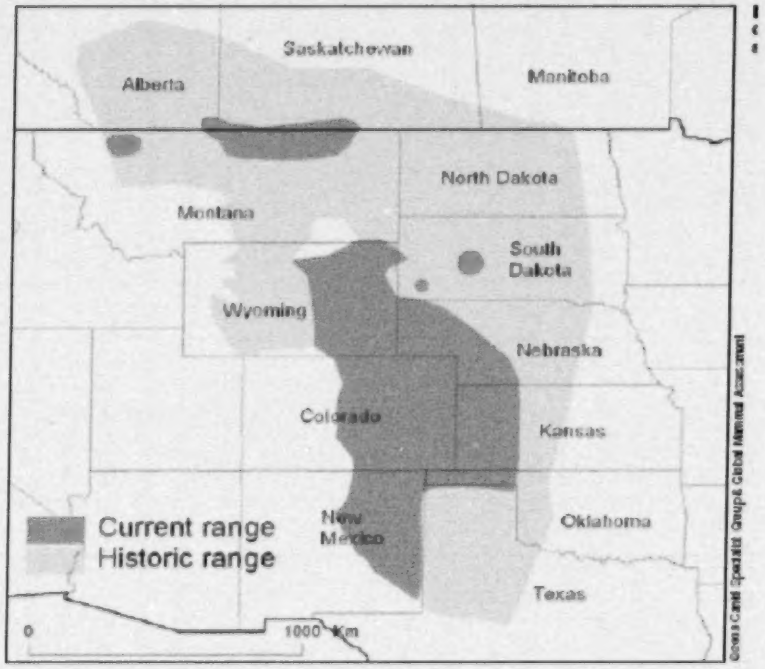

Figure 2. Historic and current distribution of Swift Foxes in North America (© 2003 Canid Specialist Group and Global Mammal Assessment).

Following extirpation from Canada in the late 1930s, Swift Fox reintroduction programmes were initiated in 1983 (Carbyn 1998). There are currently two self-sustaining Swift Fox populations in Montana, one of which is contiguous with adjacent Canadian populations and has arisen as a result of the Canadian reintroductions (Moehrenschlager and Moehrenschlager 2006). The other population occurs to the west on the Blackfoot Reservation (Ausband and Foresman 2007). This reintroduced population is quickly expanding by natural dispersal to vacant habitat over 100 km from the original release site (Giddings 2006).

Canadian range

Swift foxes were once abundant in Canada. Between 1853 and 1877, 117,025 were traded by the Hudson's Bay Company (Rand 1948), although the harvest decreased to a yearly average of only 508 pelts between 1922 and 1925 (Carlington 1980). Prior to 1900, the Canadian distribution of Swift Foxes approximated the Mixed Prairie Ecoregion in southern Alberta, Saskatchewan, and Manitoba (Merriam 1902; Seton 1909; Rand 1948; Soper 1964; Carbyn 1998), extending from the Pembina Hills in Manitoba west to the foothills of the Rocky Mountains in Alberta (Soper 1964; Carlington 1980). The northern distributional limit in Canada was originally the 53rd parallel in Alberta (Soper 1964). The last Swift Fox specimen collected in Canada prior to reintroduction was in 1928 near Govenlock, Saskatchewan, 14 km east of the Alberta border and 28 km north of the US border (Carbyn 1998). The last confirmed sighting of a Swift Fox in Canada prior to reintroduction was in 1938 near Manyberries, Alberta (Soper 1964). The species was designated as Extirpated by COSEWIC in 1978 (Saskatchewan Department of Tourism and Renewable Resources 1978). From 1983 to 1997, 805 Swift Foxes were released into southern Alberta and Saskatchewan; in 2004, 15 animals were reintroduced to Blood Tribe lands in southwestern Alberta (see **Reintroduction** section).

To monitor restoration in southeastern Alberta and southwestern Saskatchewan, population censuses using live-trapping and sign surveys have been carried out every five years since 1996. In this region, there are two populations (Figure 3), although the distinction is gradually blurring owing to increasing evidence of connectivity between them (Moehrenschlager and Moehrenschlager 2006; Ausband and Moehrenschlager 2009). One population occurs in the Alberta-Saskatchewan border area (hereafter referred to as the Border population; Figure 4). The second occurs in the Grasslands National Park region (hereafter the GNP population; Figure 5). These populations are loosely connected by contiguous habitat that extends into northern Montana. Ausband and Moehrenschlager (2009) suggest that these populations (including northern Montana) should be considered one metapopulation based on evidence of long-distance dispersal of Swift Foxes between areas.

The three censuses since 1996 have used standardized methodology, although sampling effort increased each time to assess range expansion. This has enabled some evaluation of trends in distribution, number of animals, and the proportion of wild-born individuals in the Swift Fox population on both sides of the border since the reintroductions. Overall, the known Swift Fox distribution in the contiguous Alberta-Saskchewan-Montana region significantly increased in Canada because of a greater survey effort and also because of a greater occurrence of Swift Foxes in resurveyed regions. Most range expansion in the population at large since 2001 has taken place on the Montana side of the border (Moehrenschlager and Moehrenschlager 2006).

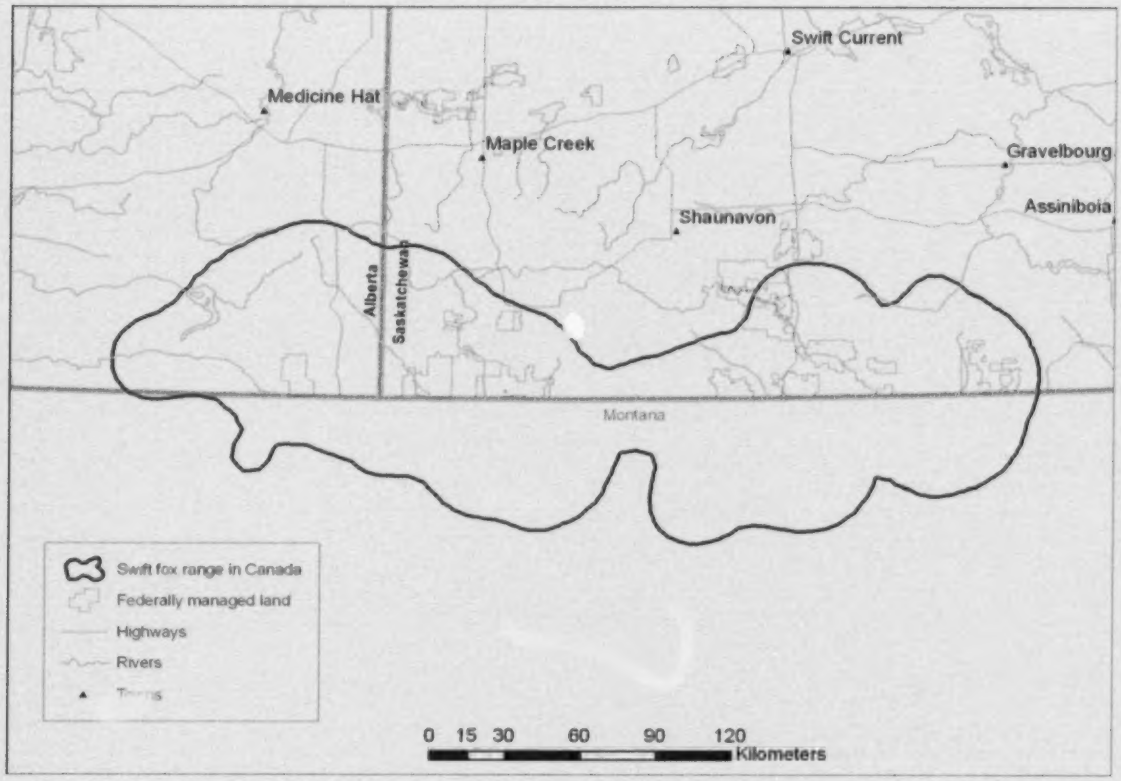

Figure 3. Map of current Swift Fox distribution in Canada and northern Montana produced using all confirmed locations of the species (reputable observer, road kill, live trap, or remote camera) recorded since the early 1990s less 9 points that were deemed to be outliers. The boundary shown uses a 99% kernel density estimator (map produced by Parks Canada).

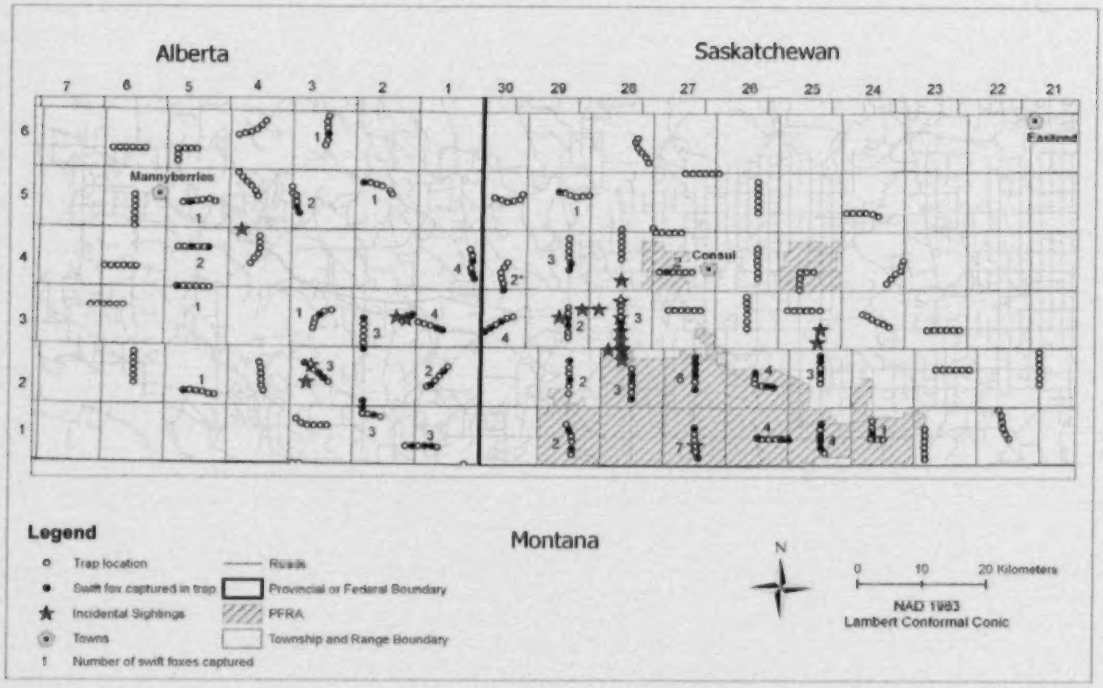

Figure 4. Map showing trap locations, numbers of Swift Foxes captured, and incidental sightings in the Border population during the 2005–2006 census (from Moehrenschlager and Moehrenschlager 2006).

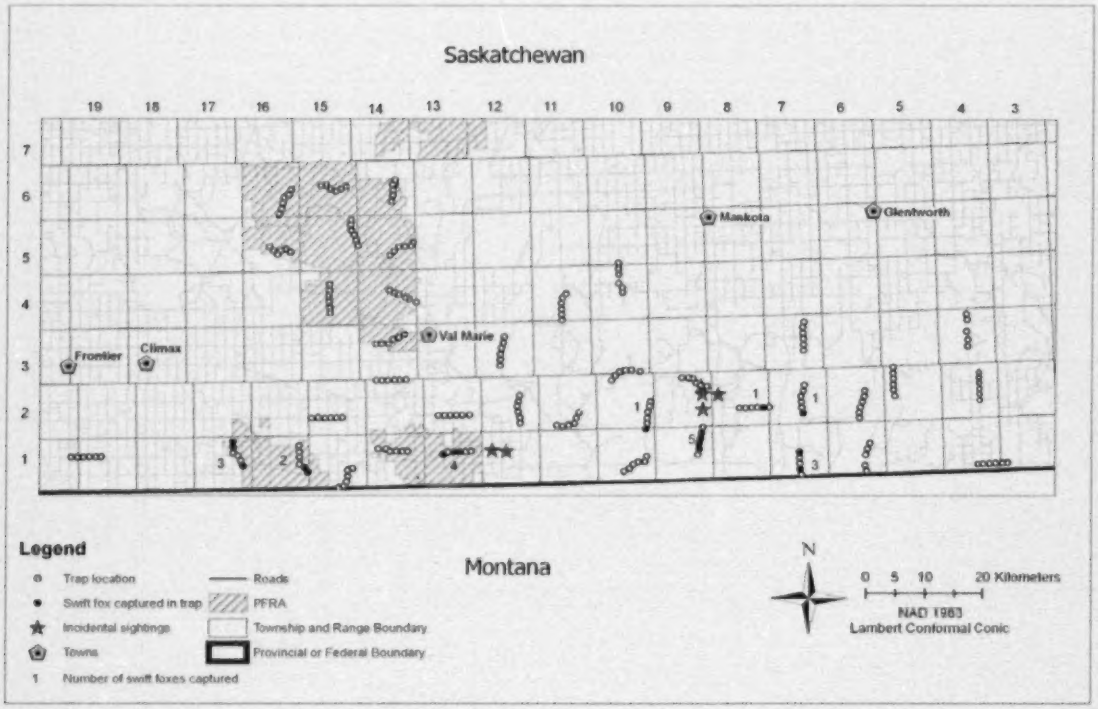

Figure 5. Map showing trap locations, numbers of Swift Foxes captured, and incidental sightings in the GNP population during the 2005–2006 census (from Moehrenschlager and Moehrenschlager 2006).

Beyond core Swift Fox range, post-reintroduction sightings have been documented in Suffield, Alberta and north of Swift Current, Saskatchewan. Carbyn (1998) reported on one 1997 sighting near Glenboro in south-central Manitoba when a Swift Fox was photographed at a den in atypical habitat on the edge of an agricultural field. This location was almost 600 km from the nearest known occurrence of this species in Canada (i.e., GNP East Block), and at least 300 km from the nearest sighting in the US (i.e., Morton or Cass County, North Dakota).

The current estimate of Swift Fox extent of occurrence (EO; based on a minimum-sided polygon encompassing the entire Canadian range [IUCN Standards and Petitions Working Group 2008]) of Swift Foxes in Canada is 21,544 km^2. This is about 2% of global EO (ASFRT 2007). Connectivity has improved with fox captures separated by no more than one township in 2005-6 as compared to three in 2000/2001 (Moehrenschlager and Moehrenschlager 2006), along with evidence of dispersal between populations (Ausband and Moehrenschlager 2009).

Between 2000–2001 and 2005–2006, the estimated area of occupancy (AO; area within EO occupied by Swift Foxes) for Swift Foxes in Canada increased by 7% (5,901 km^2 to 6,343 km^2 [Moehrenschlager and Moehrenschlager 2006; see ASFRT 2007]). This measure of area of occupancy is equivalent to an Index of Area of Occupancy (IAO; IUCN Standards and Petitions Working Group 2008). Although not based on the use of a grid of 2x2 km^2, the approach used by Moehrenschlager and Moehrenschlager (2006) using townships yields an IAO that should be close to the value derived from using the 2x2 km^2 grid methodology. The latter value would be difficult to calculate given the fact that not all townships were surveyed and the limited information on occupied vs. unoccupied habitats.

Reintroduction

Canada

Swift Foxes are vulnerable to trapping, and thus it is highly unlikely that they remained undetected for 45 years between the last confirmed sighting in 1938 and the first reintroductions in 1983. Hence, current populations of Swift Foxes in Canada are entirely attributable to reintroductions. About 90% of the Swift Foxes released in the Alberta-Saskatchewan border region and the GNP/Wood Mountain area came from captivity (Carbyn 1998). These were supplied by Cochrane Ecological Institute (formerly the Wildlife Reserve of Western Canada) of west-central Alberta which began a Swift Fox breeding program in 1971. Other facilities that contributed include: Calgary Zoo (Alberta; 1983–1994), Moose Jaw Wild Animal Park (Saskatchewan; 1984–1995), and Edmonton Valley Zoo (Alberta; 1989–1997) (Carbyn 1998). From 1973 to 1986, 151 Swift Foxes were imported from the US either for release or captive-breeding; with 99 from Wyoming, 40 from Colorado, and 12 from South Dakota (Carbyn 1998).

From 1983 to 1996, 479 Swift Foxes were released in the Alberta-Saskatchewan border area, and from 1990 to 1997, 420 individuals were released into the GNP and Wood Mountain areas (GNP population; Figure 6; for details see Carbyn 1998).

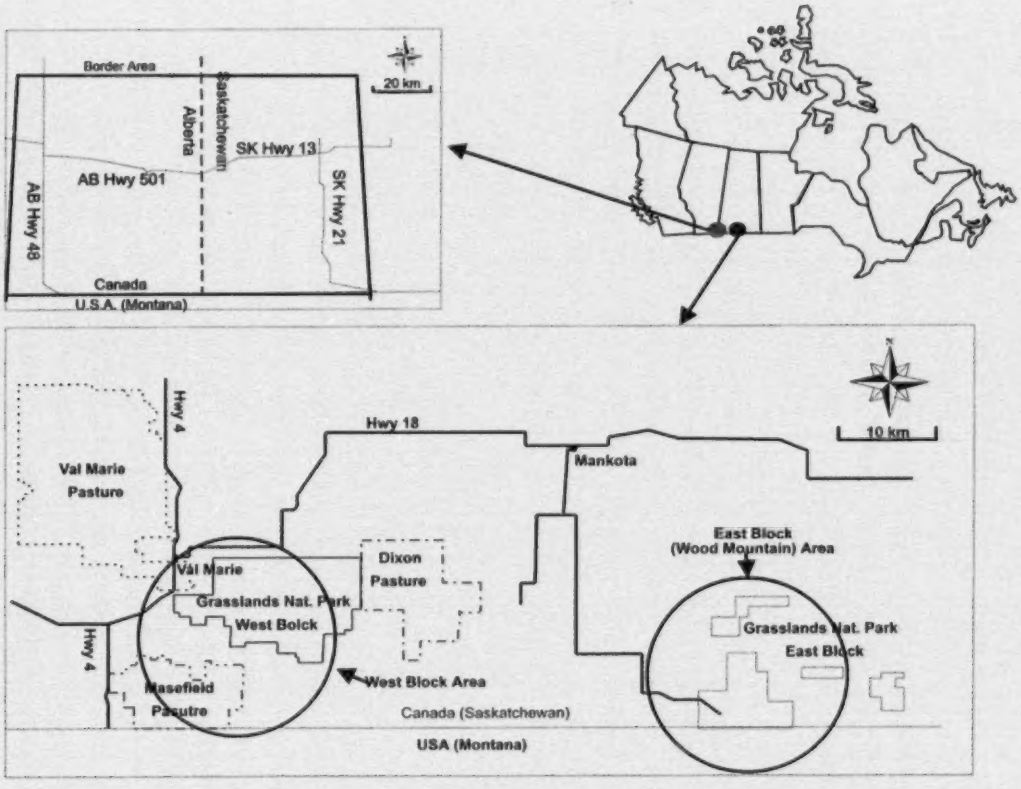

Figure 6. Location of Swift Fox release sites for the Border population (top) and the GNP population (bottom) (from Smeeton and Weagle 2000). Prairie Farm Rehabilitation Administration (PFRA) Community Pastures have been mistakenly labelled as "pastures" and AB Hwy 48 in upper left map should be labelled as AB Hwy 41.

The last releases into the Border and GNP populations occurred in 1996 and 1997, respectively. Both populations have persisted without supplementation for more than 10 years. By 1996–1997, 81.3% of the captured Swift Foxes were wild-born (Cotterill 1997b), increasing to 98.6% by 2000–2001 (Moehrenschlager and Moehrenschlager 2001). In 2005–2006, all captures were of non-translocated, wild-born individuals (Moehrenschlager and Moehrenschlager 2006).

In 1989, a reintroduction was also attempted in the Milk River Ridge area of south-central Alberta with the release of 61 individuals (Brechtel *et al.* 1993). This program was discontinued after only one year due to high predator abundance and intensive predator and rabies control programs (Brechtel *et al.* 1993). Since this time there has not been any compelling evidence about Swift Foxes in the region over the last couple of decades including the existence of reproductively active animals that might contribute to the augmentation of an existing population or to a metapopulation (A. Moehrenschlager, 2009.).

In 2004, 15 Swift Foxes were released onto Blood Tribe lands in southwestern Alberta in a 1,424-km^2 area of fescue prairie and foothills (Smeeton 2006). This area, to the west of current Swift Fox range, was within dispersal distance of the Blackfoot lands in Montana where reintroductions during 1998–2002 had established a small population of foxes (Ausband 2005). A verbal report to the Swift Fox Recovery Team from Blood Tribe staff in 2005 (J. Nicholson 2009) indicated that the five radio-collared individuals from this effort either went missing (3), shed their collar (1) or were found dead (1), and there has been no additional documented follow-up. Future reintroductions in the context of national Swift Fox recovery in the same area are currently being discussed (ASFRT 2007).

United States

Swift Foxes were extirpated from Montana by the mid-1950s (Hoffman *et al.* 1969). The Canadian reintroduction program in Alberta and Saskatchewan has been responsible for producing at least two apparently self-sustaining Swift Fox populations along the Canadian border and in Montana (see Global Range section; Zimmerman 1998). Elsewhere in the US range, Swift Fox reintroductions have occurred with some success in South Dakota (Grassel 2007; Dowd Stukel 2008; Licht and Schroeder 2008; Odell 2008) and other areas of Montana (Ausband and Foresman 2007; Kunkel *et al.* 2008).

HABITAT

Habitat requirements

Preferred habitat is short- or mixed-grass prairie on level terrain or gently rolling hills (Cutter 1958a; Kilgore 1969; Hillman and Sharps 1978; Hines 1980). Swift Foxes occasionally occur on fallow cultivated lands, usually adjacent to short-grass prairie (Cutter 1958a; Kilgore 1969; Floyd and Stromberg 1981; Jackson 1997; Sovada *et al.* 1998; Matlack *et al.* 2000). They usually select areas where vegetation is short (25 cm or less) and sparse, and with minimal topographic features such as canyons, steep hills, or coulees (Whitaker Hoagland 1997). This habitat use likely allows for long sight-lines that reduces predation risk (Pruss 1999).

In Canada, Swift Foxes prefer native grassland over cropland (Carbyn 1998). While survival rates of Swift Foxes living in fallowed sunflower fields in Kansas were similar to those of foxes living in prairie habitat (Sovada *et al.* 1998; Matlack *et al.* 2000), farmland in Canada does not appear to be similarly usable, likely due to the different nature of agricultural systems. Availability of mixed-grass prairie in Alberta and Saskatchewan therefore appears critical for reintroduction success and survival (Carbyn 1998; Smeeton *et al.* 2003). In the US, Swift Foxes sometimes occur in badlands (Wyoming; Lindberg 1986; Wooley *et al.* 1995), sand hills (Nebraska; Blus *et al.* 1967), and piñon-juniper habitat (Colorado; Covell 1992). While Swift Foxes can occur in a variety of habitats, ranging from mixed agricultural areas (Kilgore 1969; Hines 1980;

Sovada *et al.* 2003) to sagebrush steppe to short-grass prairie transition (Olson *et al.* 1997), distributional patterns of this species in Canada suggest that the context in which such habitats are situated greatly influences their relative quality.

Suitable habitat is also related to prey availability (particularly the density of fossorial mammals) and low predator abundance. There is evidence that Swift Foxes do not require standing water sources (Pruss 1999); however, proximity to permanent water does enhance habitat suitability (Mamo 1994). The presence of fossorial species, like American Badgers (*Taxidea taxus*) and Ground Squirrels (*Spermophilus* spp.) is presumably desirable, providing Swift Foxes with burrows, which they readily modify (Carbyn 1998). However, when soil type allows, they will excavate their own dens (Carbyn 1998). Density and distribution of dens is also an important habitat feature (Herrero *et al.* 1991), particularly for avoiding Coyote predation or Red Fox competition (Tannerfeldt *et al.* 2003).

Moehrenschlager *et al.* (2007a) used analyses of population census data to assess critical habitat characteristics that predict Swift Fox occurrence. They developed model parameters from winter live-trap survey data collected in Alberta, Saskatchewan, and Montana between 15 October 2005 and 15 February 2006. They also used satellite image data from August 1999 and September/October 2000 to assess 15 environmental variables in the trapping area that might be useful in predicting Swift Fox distribution. Four habitat parameters successfully explained variation in Swift Fox presence: moisture, topography, cropland, and habitat fragmentation. Swift Foxes primarily occurred in relatively dry areas and tended to avoid areas with large elevation changes, preferring habitats with gently sloping terrain. Swift Fox dens are often located on slightly raised areas (Pruss 1999; Tannerfeldt *et al.* 2003). Cropland and the presence of Swift Fox were negatively associated. There are reports of Swift Foxes inhabiting agricultural areas (Sovada *et al.* 1998; 2001), but at sites that tend to be left fallow in alternate years. Swift Fox also avoided fragmented landscape, edge habitats, and roads. Habitat parameters affected the occurrence of Swift Foxes more than 5 km from their release site, likely owing to home range size (Moehrenschlager *et al.* 2007a). From October 2008 – April 2009, A. Moehrenschlager conducted surveys with scent-post camera-traps in 32 previously sampled and 28 unsampled townships in the western half of the Canadian Swift Fox range. Results from this effort suggest that the model is not only predictive of fox presence/absence among censuses, but also highly predictive of Swift Fox presence in previously unsurveyed regions (A. Moehrenschlager 2009).

Habitat trends

Swift Foxes inhabit some of the most modified landscapes in North America. The Prairie Ecozone represents about 5% of Canada's land area, of which 52% lies in Saskatchewan and 34% in Alberta (Gauthier and Wiken 2003). Current estimates indicate that only 25–30% of native Canadian grassland habitats remain, concentrated in southeastern Alberta and southwestern Saskatchewan (Hammermeister *et al.* 2001).

The substantial conversion of native Canadian prairie habitats to agricultural uses was the most important contributor to the historic contraction of Swift Fox range (Hillman and Sharps 1978). In areas of prime cropland in Saskatchewan, less than 2% of native prairie remains (Prairie Conservation Action Plan [PCAP] Partnership 2003).

In recent times, the dominant agent of Swift Fox habitat loss has shifted from agriculture to industrial energy development and associated road networks. In both Alberta and Saskatchewan, rapidly expanding energy-related development (e.g., roads, wells and service trails) is encroaching on many native prairie remnants, contributing to continued fragmentation of the landscape (Carbyn 1998; Moehrenschlager 2000; Forrest *et al.* 2003; Samson *et al.* 2004). Previously isolated native grassland areas are being increasingly targeted for such activities. Moehrenschlager and Moehrenschager (2006) commented on the "unprecedented levels" of oil and gas industrial development during the latest census as compared to the early 1990s. There are also a number of significant wind energy development projects at various stages of approval and construction in the region. This includes a recent resolution sponsored by Cypress County to seek permission from the Alberta government to install wind energy facilities on Crown lease lands in the heart of Swift Fox range (Binder 2009).

Continued demand for fossil fuels likely means that an increasing number of areas will be targeted for exploration with negative consequences for Swift Foxes. Issues associated with this type of disturbance include general habitat degradation and loss, reductions in prey availability, increasing risk of predation by, and interspecific competition, with other predators, significant increases in traffic and road-induced mortality, auditory disturbance, and increase in structure in grassland habitats providing perches for raptors (Moehrenschlager and Sovada 2004; Doherty *et al.* 2008).

In addition to physical changes in Swift Fox habitat from grassland conversion, the prairies have also experienced other significant biological changes. Plains Bison (*Bison bison*) were the predominant ungulate grazer until about 1870 and have been replaced by cattle, which differ in their grazing patterns. From 1956 to 1976, grazing pressure on mixed-grass prairie increased by one-third in Saskatchewan and one-half in Alberta (Coupland 1987). Changes in grazing patterns and intensity have altered vegetative cover and plant composition, and consequently, the composition and distribution of Swift Fox prey. For example, Swift Foxes prefer areas with sparse vegetation, interspersed with sites suitable for their small mammal prey (Carbyn 1998). In heavily cultivated areas of southern Saskatchewan, small mammals were abundant in all habitat types except pastures (Sissons *et al.* 2001), which likely negatively affected Swift Foxes. Well-managed rangeland with grazing regimes that increase rodent abundance should provide suitable year-round habitat for Swift Foxes (ASFRT 2007).

Climate change may also stimulate habitat modifications. Most models predict the Canadian prairies will experience mean annual temperature increases, resulting in droughts of increased extent and severity (e.g., Sauchyn *et al.* 2002; Bonsal and Regier 2007). Increased drought could alter the structure and composition of vegetation and thus Swift Fox populations (Lawton 1993). Additionally, altered landscapes could lead to

changes in the abundance and/or distribution of Swift Fox prey, predators, and interspecific competitors, potentially leading to population decline.

The historic extent of potential Swift Fox habitat in Canada has decreased by 58% Gauthier and Wiken 2003). Within the remaining areas, Swift Foxes avoid those with greater topographic relief and shrubland, which are least likely to be converted to cropland. Thus, optimal Swift Fox habitat constitutes only a fraction of the remaining grasslands (Carbyn 1998). Results from recent habitat modelling and validation efforts indicate little potential Swift Fox habitat beyond that which is currently occupied. Existing Swift Fox range is slowly degrading in certain regions primarily due to expanding oil and gas exploration and associated road/trail networks (A. Moehrenschlager. 2009.).

Habitat protection/ownership

Of the remaining native grasslands on the Canadian prairies, 45% are potentially arable and at risk of being cultivated (Erickson *et al.* 2004). Saskatchewan has 28% of its grasslands protected in conservation areas but Alberta has only 2% (Gauthier and Wiken 2003). However, Alberta Crown lands under grazing disposition are managed with a no cultivation policy, thereby minimizing the danger of being ploughed for annual crops.

Although the Prairie Farm Rehabilitation Administration (PFRA) Community Pastures Program has returned more than 145,000 ha of poor-quality cultivated lands to grass cover (PFRA 2008), exotic forage species likely compromise its suitability as Swift Fox habitat. In addition, the Saskatchewan Representative Areas Network Program aims to conserve representative and unique examples of varied and diverse landscapes. Since being launched in 1997, more than two million hectares of both Crown and privately owned land have been added to the nearly three million hectares of existing protected lands (e.g., parks, ecological reserves; Saskatchewan Environment 2006). Legislation in Saskatchewan under the *Wildlife Habitat and Protection Act* currently prohibits the breaking of native grasslands on about two million hectares of Crown land.

BIOLOGY

Population dynamics

Swift Foxes generally live in socially monogamous pairs (Kilgore 1969), although extra-pair mating also occurs (Kitchen *et al.* 2006). A typical social group consists of a mated pair with kits; additional non-breeding females may act as helpers to raise kits (Kilgore 1969; Covell 1992; Olson *et al.* 1997; Sovada *et al.* 2003; Tannerfeldt *et al.* 2003). In Alberta, a male was observed with the litters of two different females on the same day (Moehrenschlager 2000). Concurrent den sharing and home range use (particularly during the mating season) occurs in Alberta and Saskatchewan (Carbyn *et*

al. 1994). Kamler *et al.* (2004) assessed the relationship between Swift Fox density,mating systems and group structure in northwestern Texas. Although high- and low-density populations were separated by only 40 km, and vegetation and diets were similar between sites, polygynous groups, communal denning, and non-breeding females occurred in the high density area, whereas only monogamous pairs occurred at the low density site.

Swift Foxes begin breeding in mid-February in Canada (Moehrenschlager and Macdonald 2003). Females are monoestrous (Kilgore 1969). Gestation is about 51 days (Schroeder 1985) and litter size is usually about four kits (Kilgore 1969; Hillman and Sharps 1978; Moehrenschlager 2000; Olson and Lindzey 2002), but can be as high as eight (Moehrenschlager 2000). Both parents care for the young. Litters are larger when helpers are present (Covell 1992). Kits weigh 50–100 g at birth, their eyes open at 10–15 days. They emerge from the natal den at about four weeks and are weaned at 6–7 weeks (Kilgore 1969; Hines 1980). Although kits break close associations with their parents at 4–6 months (Covell 1992), Moehrenschlager (2000) found that only 33% (n=12) of juveniles had left natal home ranges by 9.5 months. By 18 months, all had dispersed. Both males and females are sexually mature by the end of their first year (Kilgore 1969; Morgan Ernest 2003), but not all first-year females breed (Carbyn 1998).

Swift Foxes generally live 3-7 years in the wild (Reid 2006). In captivity, an individual lived to nearly 13 (Kilgore 1969; Egoscue 1979). In the border region, annual adult survival rates range from 0.38 (95% CI = 0.15-0.60) to 0.63 (95% CI = 0.23-0.86) (Moehrenschlager *et al.* 2007b), similar to estimates from the core range in the US (Covell 1992; Sovada *et al.* 1998; Kitchen *et al.* 1999; Olson and Lindzey 2002; Schauster *et al.* 2002; Zimmerman *et al.* 2003). Juvenile survival in the border region (0–0.50, Moehrenschlager *et al.* 2007b) is also similar to the US (0.13–0.69, Covell 1992; Sovada *et al.* 1998; Kitchen *et al.* 1999; Schauster *et al.* 2002). Moehrenschlager and Macdonald (2003) reported that survival rates of translocated Swift Foxes were similar to wild residents. Mortality is primarily attributable to natural predation or human causes. There is no evidence that disease is an important source of mortality (Moehrenschlager *et al.* 2004). Direct human-caused mortality is caused by poison, shooting, collisions with vehicles, and trapping (Kilgore 1969; Carbyn *et al.* 1994; Pruss 1994; Sovada *et al.* 1998). Predation by Coyotes is the principal cause of mortality (Covell 1992; Carbyn *et al.* 1994; Sovada *et al.* 1998; Kitchen *et al.* 1999; Andersen *et al.* 2003; Moehrenschlager *et al.* 2007b).

Denning

A major factor influencing maintenance of viable populations is availability of suitable dens (Egoscue 1979; Pruss 1999; Harrison and Whitaker Hoagland 2003). Swift Foxes use dens throughout the year (Kilgore 1969; Egoscue 1979; Hines 1980; Tannerfeldt *et al.* 2003). They serve as refugia from predators, protection from extreme climatic conditions, prevention of water loss, periodic rest sites, and secure places to raise young (Cypher *et al.* 2003; Tannerfeldt *et al.* 2003). Swift Foxes use many dens concurrently (Moehrenschlager *et al.* 2004), usually concentrated within a 1–2 km^2 area

(Pruss 1994; Tannerfeldt *et al.* 2003), but throughout the home range (Moehrenschlager *et al.* 2004). Swift Foxes will use other appropriately sized holes to evade predators (Pruss 1999). In Canada, pairs may use up to eight multiple entrance dens when rearing young (Pruss 1994; Tannerfeldt *et al.* 2003) and up to 22 dens per year (Moehrenschlager 2000). They reuse den sites in subsequent years (Pruss 1994; Moehrenschlager 2000; Tannerfeldt *et al.* 2003) and change dens frequently (Kilgore 1969).

Swift Fox dens primarily occur in short- or mixed-grass prairie (Kilgore 1969; Uresk and Sharps 1986). In Canada, they are almost exclusively on native prairie with unobstructed views of the surroundings (Carbyn 1998). Dens typically occur in areas with well-drained soils, usually on the tops of hills with gradual slopes (Cutter 1958a; Uresk and Sharps 1986; Pruss 1999). Natal dens in Canada are on average 267 m from the nearest road and 1 km from the nearest water source (Pruss 1999). Burrow openings are about 20 cm in diameter (McGee *et al.* 2006a) which likely precludes entry by Coyotes. In spring and summer, dens used for raising kits typically have one or two central chambers extending to a depth of 1 m, and connected to the surface by many tunnels (Cutter 1958a; Kilgore 1969). Dens used for shelter and predator avoidance have fewer entrances (Hillman and Sharps 1978; Pruss 1999; Moehrenschlager 2000; Olson 2000).

Dirt tailings and entrance size distinguish Swift Fox dens from Coyote and Red Fox dens (McGee *et al.* 2006a). Ninety-six percent (n=74) of Swift Fox dens had conspicuous dirt tailings at entrances and den openings smaller than those of Coyotes and Red Foxes.

Swift Foxes can excavate their own dens, but frequently enlarge burrows of ground squirrels, prairie dogs (*Cynomys* spp.), or American Badgers (Cutter 1958a; Kilgore 1969). Although most dens are built in natural substrates, human-made structures such as pipes, culverts, buildings, and rubble piles may also be used (Moehrenschlager *et al.* 2004). Pruss (1994) found that shifts between dens did not exceed 500 m; however, Moehrenschlager (2000) recorded a pair moving a litter of seven kits 1.9 km.

Diet and foraging behaviour

Swift Foxes are opportunistic foragers, primarily eating mammals, but also birds and their eggs, insects, plants, and carrion (Cutter 1958b; Kilgore 1969; Hines 1980; Cameron 1984; Uresk and Sharps 1986; Hines and Case 1991; Pruss 1994; Zimmerman 1998; Kitchen *et al.* 1999; Sovada *et al.* 2001). In the border region, scat analysis revealed that mammals are the most frequent prey (68.3%: rodents – 59.5%; lagomorphs – 7.1%; large mammals [presumably carrion] – 1.7%), insects (23.8%), and birds (8.0%) (Moehrenschlager *et al.* 2007b). Reynolds *et al.* (1991) found that small rodents and carrion from ungulates were most important with a small portion from lagomorphs and ground squirrels. Typically, relatively high frequencies of insects and plant matter occur in the diet; but these items constitute a small portion of total biomass (Kilgore 1969; Harrison 2003; Moehrenschlager *et al.* 2004; Kamler *et al.* 2007a).

Swift Fox diets vary geographically, depending on the local assemblage and prey abundance. Murid rodents were the most frequent prey of Swift Foxes in Kansas and Nebraska (Hines and Case 1991; Sovada *et al.* 2001), although leporids are also common (Cutter 1958b; Cameron 1984; Zumbaugh *et al.* 1985). Black-tailed Prairie Dogs (*Cynomys ludovicianus*) are most important in South Dakota (Uresk and Sharps 1986); but unlikely to be important (Carbyn 1998). In general, prey are not larger than White-tailed Jackrabbits (*Lepus townsendii*; 3–4 kg).

In the northern part of their range, prey selection reflects differences in availability between summer and winter. For example, ground squirrels and grasshoppers (*Melanoplus* spp.) are important in summer (Carbyn 1998). In winter, Swift Foxes probably switch to lagomorphs.

Swift Foxes are mostly solitary hunters, exhibiting seasonal variation in activity periods (Carbyn 1998). Activity is correlated with day length and varies with temperature (Carbyn 1998). Swift Foxes are largely nocturnal in winter, but become more crepuscular in summer (Moehrenschlager *et al.* 2004). In spring and summer, Pruss (1994) reported activity over extended periods during day and night. Swift Foxes tend to follow predictable routes while hunting, such as along fence lines, ridges, roads, and trails (Carbyn 1998). Food is sometimes cached (Pruss 1994; Sovada *et al.* 2001).

Physiology

Temperatures on the prairies range from near -40°C in winter to +40°C in summer (National Climate Data and Information Archive 2002). Behaviourally, Swift Foxes thermoregulate and conserve water by timing activity bouts and using dens. On cold, sunny winter days, they often sun themselves at den entrances (Carbyn 1998). When free water is available, a Swift Fox requires about 210 g of food per day; in the absence of water, moisture requirements can be satisfied solely from food, by eating about 330 g per day (Flaherty and Plaake 1986).

Movement and dispersal

Although homes ranges can overlap, there is nearly total separation of core activity areas of adjacent same-sex individuals, suggesting territoriality (Pechacek *et al.* 2000; Andersen *et al.* 2003; Sovada *et al.* 2003). For example, Canadian Swift Fox home ranges (including Montana) overlapped by 74% among mates and only 29% between neighbours (Moehrenschlager *et al.* 2007b).

In Canada, young Swift Foxes begin to disperse in August (Pruss 1994; Moehrenschlager 2000). However, 6 weeks before the subsequent breeding season, up to two-thirds of juveniles in Alberta and Saskatchewan remained within natal home ranges (Moehrenschlager *et al.* 2004). By 18 months of age, all foxes had dispersed (Moehrenschlager and Macdonald 2003). Normal dispersal distance is <15 km (Covell 1992; Moehrenschlager 2000; Schauster 2001; Sovada *et al.* 2003). Long distance dispersal of five wild-born juveniles from the Blackfoot Reservation (range=43.1-55.8

km, with one covering a distance of 190.9 km) were recorded (Ausband and Moehrenschlager 2009). Swift Foxes translocated from Wyoming to Colorado dispersed mean distances of 27 km (adults) and 19 km (juveniles) (Moehrenschlager 2000). Males disperse farther than females (Covell 1992; Moehrenschlager 2000). In Texas, Nicholson *et al.* (2007) found that dispersal direction reflected land use practices with animals usually dispersing to rangeland and away from anthropogenic features.

Swift Fox home range size, while correlated with prey abundance, varies significantly with method of calculation, seasons, and sample size (Hines and Case 1991; Kitchen *et al.* 1999; Pechacek *et al.* 2000; Andersen *et al.* 2003; Harrison 2003; Sovada *et al.* 2003; Zimmerman *et al.* 2003). Home range size of 36 Swift Foxes in the border region based on the fixed kernel method was 31.9 ± 4.8 km^2 (Moehrenschlager *et al.* 2007b). Average home ranges of Canadian Swift Foxes, residing at the northern periphery of the global range of the species, are approximately three times larger than Canadian kit fox from Mexico (Moehrenschlager *et al.* 2007).

Interspecific interactions

Coyotes are important predators of Swift Foxes in Canada and with Red Foxes likely compete with Swift Foxes (see **Limiting factors and threats** section).

Adaptability

Swift Fox adaptations for life on the prairies include their opportunistic foraging strategy and use of dens for shelter and protection from predators (Pruss 1999; Allardyce and Sovada 2003; Harrison and Whittaker Hoagland 2003; Tannerfeldt *et al.* 2003). In response to the extreme climate of the prairies, they thermoregulate and reduce water loss by adjusting activity periods and burrow use (Pruss 1994). Their feet are well-insulated with the foot pads being almost entirely covered by fur (Egoscue 1979).

As their name suggests, Swift Foxes are fast runners, able to reach speeds of 60 km/hr. Their slender skeleton and long legs are adapted for running (Egoscue 1979), which helps them evade predators and hunt fast prey e.g., lagomorphs.

POPULATION SIZES AND TRENDS

Search effort

Population censuses using live-trapping and sign surveys have been conducted every five years between 1996 and 2006 during winter months (November-February). The area surveyed was determined by the Canadian Swift Fox Recovery Team based on habitat criteria (Cotterill 1997a). The survey area was expanded in subsequent surveys to track range expansion. Surveys enabled population estimates for 1996–1997, 2000–2001, and 2005–2006, although confidence limits around these estimates are not yet available.

The study area for the 2005–2006 census extended roughly from Manyberries, AB, east to Glentworth, SK (106° 33' W – 110° 50' W), and from Eastend, SK, south to Dodson, MT (48° 24' N – 49° 31' N). In total, 191 townships, covering 12,717 km^2 were surveyed (Moehrenschlager and Moehrenschlager 2006). This included 4,061 km^2 in 62 townships for the Border population, 2,550 km^2 in 38 townships in the GNP population, and 6,106 km^2 in 91 townships in Montana. The area surveyed was 26% larger than in 2000–2001.

Due to logistical constraints associated with winter trapping, traditional population estimation methods are not possible from census data, thus catch-and-release live-trapping was employed, based on a calibration-based census design (see Cotterill 1997a). In each township, one 5 km transect along a continuous trail was laid out near the township centre. Traps were placed along fences or on hilltops at approximately 1 km intervals on the transect (Moehrenschlager and Moehrenschlager 2006). Home range data were used to estimate the area sampled per trap, as well as trappability, data necessary for estimating abundance. A correction factor was used to account for trapping success and trappability of animals for which a home range estimate was available (correction factor = [foxes available for capture] / [captured foxes from known home ranges = 3.5]. A fox was considered available for capture when more than 50% of its home range fell within one home range radius of a trap). The correction factor was applied to all population calculations (Cotterill 1997a).

Each transect received 18 trap nights (i.e., six traps on three nights), amounting to a total effort of 3,438 trap nights (Moehrenschlager and Moehrenschlager 2006). This was a 28% increase over the 2000–2001 census and a tripling of effort from 1996–1997. Incidental sightings of Swift Foxes were also recorded; however, unlike in the previous census, spotlighting and snow-tracking were not used.

Abundance

Based on live-trapping data from 2005–2006, there are an estimated 513 Swift Foxes in the Border population and 134 in GNP (Moehrenschlager and Moehrenschlager 2006). The neighbouring northern Montana population had an estimated 515 foxes. The census data have not yet undergone bootstrap analyses, and

thus, confidence intervals are not available. Thus population estimates from 2000–2001 and 2005–2006 are overly precise and can only be considered as the best fit to the available data. In total, the Canadian population is estimated to be 647. Because surveys were conducted just before the onset of the breeding season and both males and females reach sexual maturity in one year, this count refers to number of mature individuals.

Fluctuations and trends

Based on the 1991–1992 survey, the Canadian population was estimated to be 225 individuals (range: 150–300; Brechtel *et al.* 1993). This increased to 289 in 1996-1997 (95% confidence interval: 179–412; Cotterill 1997b). By 2000-2001 the population had more than doubled to 656 (Moehrenschlager and Moehrenschlager 2001) and the Border and GNP populations had become contiguous through northern Montana. With an estimated 221 Swift Foxes in the Montana border population, the overall Alberta-Saskatchewan-Montana population was approximately 887. The 2005–2006 census suggests the Canadian population has remained stable while the Montana population increased to 515 foxes, for a combined 2006 population estimate of 1162 Swift Foxes (Moehrenschlager and Moehrenschlager 2006).

Since 2001, the Border population has expanded from 18 to 32 townships, a 78% increase (Figure 7), although the distribution has declined in the past five years (from 38 to 32 townships). However, when the data from the 48 townships included in both surveys are used, there has been a slight increase in the proportion of townships where Swift Foxes were detected, from 58 to 60% (Moehrenschlager and Moehrenschlager 2006).

The distribution of the GNP population increased to 43% (13 of 30) of townships surveyed in 2000–2001. The 2005–2006 census showed a 43% contraction in the GNP distribution, with foxes detected in only 21% (8 of 38) of townships (Figure 7). Although the distribution in GNP in 2005–2006 was less than half from five years before, for the 30 townships included in both surveys, the decrease was only 10% (Moehrenschlager and Moehrenschlager 2006).

Although the census estimates indicate increasing populations, they are confounded by the survey design, due to the inclusion of previously unsurveyed areas. Thus, the apparent increases are likely in part due to greater trapping effort.

In 2000–2001 the density of Swift Foxes in the Border and GNP populations was 6.7 per 100 km^2. Including the northern Montana population, the density was estimated at 5.1 per 100 km^2 (Moehrenschlager and Moehrenschlager 2001). Population densities were similar in 2005–2006, with the Canadian population at 5.5 per 100 km^2 and with Montana included 5.4 per 100 km^2 (Moehrenschlager and Moehrenschlager 2006).

In the latest census it was clear that improvements to the status of Swift Fox population at large were mostly attributable to the Montana portion. Specifically, over half of Montana townships that had not had captures in 2001/2 did have captures in 2005/2006, whereas this was the case for only 19.5% of Canadian townships. Similarly, while the population estimate for Canadian animals more than doubled between the first two survey periods, they did not change thereafter. By contrast, population estimates on the Montana side of the border have steadily increased in each census (Cotterill 1997a; Moehrenschlager and Moehrenschlager 2001; 2006).

Age structure and sex ratios provide insight into survival and productivity and are indicators of reintroduction success. In Canada, the proportion of adults captured increased from 50% in 1996–1997 (n=32; Cotterill 1997b), to 60% in 2000–2001 (n=107; Moehrenschlager and Moehrenschlager 2001). Age structure based on 2005–2006 census data have not been analyzed. Sex ratios shifted from 63% males in 1996–1997 (n=32; Cotterill 1997b), to 43% in 2000–2001 (n=108; Moehrenschlager and Moehrenschlager 2001), and was close to parity in 2005–2006 (52% males; n=195; Moehrenschlager and Moehrenschlager 2006). Sex ratios were not significantly different in the Border, GNP, and northern Montana populations (Moehrenschlager and Moehrenschlager 2006).

Border population

The Border population was established by reintroductions into the Lost River Ranch area on the Alberta-Saskatchewan border between 1983 and 1997. A 1989–1991 survey yielded a population estimate of 150–250 foxes (Brechtel *et al.* 1993). The population decreased to 100–135 by 1994 (Mamo 1994), but increased to 192 (95% CI: 93–346) by 1996–1997 (Cotterill 1997a). The 1999 survey showed the population had increased by 38% since 1997 (Moehrenschlager and Moehrenschlager 1999). By 2000–2001, the population was 560 (Moehrenschlager and Moehrenschlager 2001).

In 2000–2001, Swift Fox density in the Border population was relatively high at 9.3 foxes/100 km^2 (Moehrenschlager and Moehrenschlager 2001). It decreased to 7.2 in 2005–2006. The most plausible explanation for the decline is dispersal by foxes into Montana, as this population increased by 77% during the period (Moehrenschlager and Moehrenschlager 2001, 2006).

The Border population had similar proportions of adults in 1996–1997 (54%; n=24; Cotterill 1997a) and 2000–2001 (59%; n=94; Moehrenschlager and Moehrenschlager 2001). The proportion of males decreased from 54% in 1996–1997 (n=24; Cotterill 1997a) to 41% in 2000–2001 (n=95; Moehrenschlager and Moehrenschlager 2001), a change that is likely due to demographic stochasticity.

GNP population

The GNP population was established by reintroductions into the East and West Blocks of the park and the Wood Mountain area between 1990 and 1997. In 1991, the GNP population had less than 50 individuals (Brechtel *et al.* 1993). Two years later, the population was estimated to be 25 (range: 15–50; Hjertaas 1994). The 1996–1997 census indicated a population of 87 (Cotterill 1997a). The population increased to 96 by 2000–2001 (Moehrenschlager and Moehrenschlager 2001) and then to 134 by 2005–2006 (Moehrenschlager and Moehrenschlager 2006), an increase of 54% over 10 years.

Swift Fox densities in the GNP population were similar between 2000–2001 and 2005–2006 (2.4 and 2.7 per 100 km^2;respectively; Moehrenschlager and Moehrenschlager 2001, 2006).

The ratio of adults to juveniles in GNP increased from 1996–1997 (38%; n=8; Cotterill 1997a) to 2000–2001 (69%; n=13; Moehrenschlager and Moehrenschlager 2001). The percentage of males declined from 88% in 1996–1997 (n=8; Cotterill 1997a) to near parity in 2000–2001 (54%; n=13; Moehrenschlager and Moehrenschlager 2001). Age structure and sex ratios for the 2005–2006 data have not been analysed.

Rescue effect

With 100% of trapped individuals wild-born in the 2005-6 survey, it is clear that reintroduction programs in Alberta and Saskatchewan have produced self-sustaining populations. Moreover, this effort has resulted in the establishment of Swift Foxes in northern Montana, which appear to be increasing in numbers and dispersing back into Canada. Due to the connection between the Border and the GNP population through north-central Montana, the potential for a limited rescue effect therefore exists. Continued improvements in the status of Montana Swift Fox may already be contributing to the stable status of this species in Canada, where habitat degradation through energy development and associated roads is ongoing. There is little or no potential for rescue beyond the reintroduced populations directly across the US border, because the contiguous Alberta-Saskatchewan-Montana populations are disjunct from core Swift Fox range in the US.

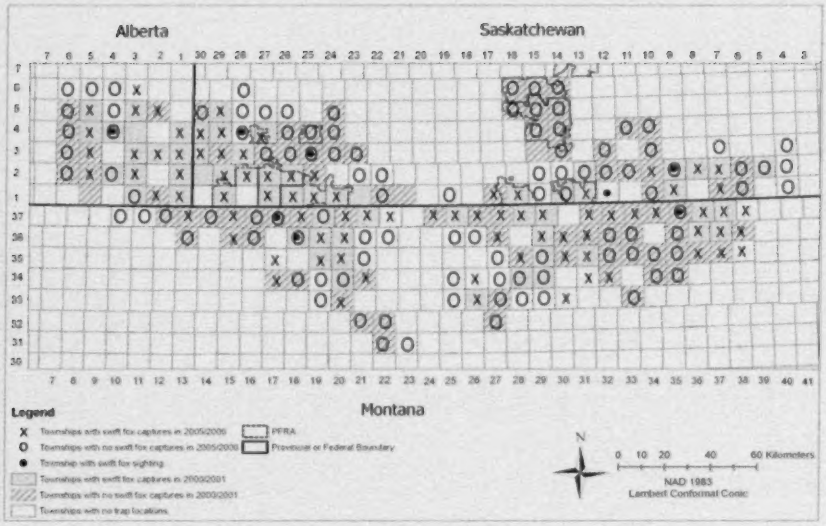

Figure 7. Comparison of townships with Swift Fox captures between 2000–2001 and 2005–2006 (from Moehrenschlager and Moehrenschlager 2006).

LIMITING FACTORS AND THREATS

The primary natural factor causing Swift Fox mortality in Canada is predation by Coyotes and Golden Eagles (*Aquila chrysaetos*), with habitat loss, degradation and disturbance from development activities and disease being additional escalating concerns. Competition with Coyotes and Red Foxes are an additional potential limiting factor. Other threats to Swift Foxes in Canada include poisoning, vehicle collisions and trapping.

Predation

Coyotes are the principal cause of Swift Fox mortality (Covell 1992; Carbyn *et al.* 1994; Sovada *et al.* 1998; Kitchen *et al.* 1999; Olson and Lindzey 2002; Andersen *et al.* 2003; Ausband and Foresman 2007). Of the 89 Alberta and Saskatchewan Swift Fox carcasses examined by Carbyn *et al.* (1994) between 1983 and 1992, 38% were thought to be killed by Coyotes, 8% were likely killed by avian predators (of which 71% were Golden Eagles), and 7% were known or suspected American Badger kills. Moehrenschlager *et al.* (2007b) found that 31% of radio-collared Swift Foxes were killed by Coyotes and 33% by Golden Eagles (n=39) and also compared intraguild predation (i.e., killing and eating among potential competitors) of Swift Foxes (including Montana) and Mexican Kit Foxes. Coyote:fox home range size ratios in Canada were approximately four times what they were in Mexico. Disparity in ratios of home range area and availability of escape holes was attributed to differences in prey diversity and abundance. Moehrenschlager *et al.* (2007b) suggested that this pattern would lead to a higher rate of encounters with Swift Foxes, and thus, increased Swift Fox mortality.

They concluded that Canadian Swift Foxes were twice as susceptible to predation in their 51–99% kernel use area than in their 50% core area. In Texas, increases in Swift Fox survival rates and recruitment occurred following Coyote control, although how long this effect persists is unknown (Kamler *et al.* 2003b). Significant reductions in Coyote populations in the Alberta-Saskatchewan-Montana border region decreased predation and/or competition; however, predation by Golden Eagles kept Swift Fox survival rates low (Moehrenschlager *et al.* 2007b). Coyote predation has hindered Swift Fox reintroduction efforts in Canada (Scott-Brown *et al.* 1987; Carbyn *et al.* 1994).

Habitat alteration and disturbance

The level of oil and gas development within the Canadian range of Swift Fox has markedly increased since 1993 (Moehrenschlager and Moehrenschlager 2006). Swift Fox den use, and survival were not adversely affected by development activities, as long as dens were not destroyed (Moehrenschlager 2000), although there was some evidence of negative effects on reproduction during pipeline construction. Swift Fox pairs along an oil pipeline corridor (n=2) did not produce any kits, whereas all pairs in the control area (n=8) did. In the year after pipeline completion, kits were produced by all ten pairs (Moehrenschlager 2000). Analyses of trapping data suggest that habitat fragmentation negatively affects fox abundance (Moehrenschlager, unpub. data).

Habitat issues lie at the root of many mortality factors for Swift Fox discussed in this section. For example, habitat conversion through agriculture (crops and/or livestock) has had indirect effects on Swift Fox populations. The extirpation of Wolves which was at least partially due to agriculture on the Canadian prairies led to Coyotes expanding in range and number (Sargeant *et al.* 1993) leading to increased predation on and competition with Swift Foxes. As pastureland increased, so did human persecution of American Badgers. This human activity likely reduced Badger predation on Swift Foxes, but in turn decreased availability of dens and escape holes to Swift Foxes.

Climate change may affect Swift Fox populations by causing spatial shifts in suitable habitat. Indirect effects of climate change will be on conditions that influence prey availability (Carbyn 1998).

Disease

To date, there have been no recorded disease outbreaks in Swift Fox populations (Moehrenschlager and Sovada 2004). Regardless, exposure to pathogens can threaten recovery efforts, particularly for small populations (Miller *et al.* 2000). Disease is well-documented in other endangered canids, with viruses such as canine parvovirus (CPV), canine distemper virus (CDV), and rabies (to name a few) having suddenly and swiftly killed large portions of small populations of Ethiopian Wolves (*Canis simensis*), Island Foxes (*Urocyon littoralis*), and African Wild Dogs (*Lycaon pictus*) in recent times (Laurenson *et al.* 1998; Woodroffe and Ginsberg 1999; Timm *et al.* 2000).

Swift fox reintroductions in Canada were originally planned at two separate locations in large part because of concerns about the potential for disease. Ironically, the success of reintroduction efforts from a demographic and genetic point of view through the effective connection of the two populations has enhanced the threat of disease through the creation of one epidemiological unit. Indeed, the potential threat is well illustrated by a limited seroepidemiological survey conduced in 2001 on 21 Canadian Swift Foxes (A. Moehrenschlager 2009). Over half tested positive for CDV antibodies, with high titres indicative of infection, all 21 had antibodies for CPV, with evidence of infection in 15. Its shared range with several domestic and free-ranging carnivores heightens the possibility of disease transfer between Swift Foxes and any number of sympatric species (Pybus and Williams 2003). Domestic dogs, in particular, are known to pose a significant risk as reservoirs for infectious diseases, especially for wild canids (Aguirre 2009). Although Swift Foxes have not been known to be reservoirs of rabies in the core of their range (Miller *et al.* 2000), this virus is enzootic in Skunks in the Canadian Prairies (Rosatte 1998) and has had well-documented devastating effects on Ethiopian Wolves and African Wild Dogs (Laurenson *et al.* 1998).

Sylvatic plague is a flea-transmitted disease caused by the bacterium *Yersinia pestis* (Olsen 1981). It causes epizootics resulting in 90–100% mortality in Prairie Dog colonies (Cully and Williams 2001; Gasper and Watson 2001). Canids are infected by flea bites or by consuming infected rodents (Thomas *et al.* 1989). Sylvatic plague is endemic (Humphreys and Campbell 1947; Leighton *et al.* 2001) to areas coincident with Swift Fox range. Antibody prevalence in Swift Foxes was 100% in northwestern Texas (n=12; McGee *et al.* 2006b), 24% in northeastern Colorado (n=61; Salkeld *et al.* 2007), 51% in southeastern Colorado (Gese *et al.* 2004) and 6% in New Mexico (n=16; Harrison 2003).

Poisoning

Historically, poisoning for predator control had serious impacts on Swift Fox populations, likely contributing to their decline in the early 20th century (Scott-Brown *et al.* 1987). Poisoning of Swift Foxes is now illegal in Canada and therefore has declined as a direct threat. A 1972 ban on predator toxicant use on US federal lands aided the recovery of Swift Foxes (Pruss *et al.* 2008). Swift Foxes readily consume poisoned baits laid out for Wolves, Coyotes, Striped Skunks (*Mephitis mephitis*), and Ground Squirrels (*Spermophilus richardsonii*) (Pruss *et al.* 2008). Despite legal protection Swift Foxes are still occasionally poisoned. Two of 39 Swift Fox carcasses examined in a Canadian study (including Montana) died from poisoning (Moehrenschlager *et al.* 2007b).

Even when Swift Foxes are themselves not targeted, the potential risk of mortality through encounter of poison baits directed at coyotes or secondary poisoning from consuming poisoned rodents is evident. The extent to which either occurs is unknown although it would stand to reason that the many poisons in use, both legally and illegally, constitute a risk factor for Swift Foxes. For example, many sheep ranchers perceive Coyotes to be a problem predator and Compound 1080 (sodium monofluoroacetate) can be used for their control in both Alberta and Sasktchewan,

although the laws limiting their use have become much more stringent than in the past. Strychnine is also used to control Coyotes in Alberta and Saskatchewan. In Alberta it comes in tablet form (50% strychnine) and may be handled only by authorized, trained provincial or municipal personnel (Pest Management Regulatory Agency [PMRA] 2005). The tablets are mixed with bait and covered with loose snow or dirt. As a precaution, product labels indicate that application is not permitted if species at risk occur in the area (PMRA 2005). Strychnine is used to control Striped Skunks (as the primary vector of rabies in Canada; Fehlner-Gardner *et al.* 2008) and ground squirrels in Alberta and Saskatchewan. Saskatchewan implemented temporary emergency control measures for Richardson's Ground Squirrel (*Spermophilus richardsonii*) in 2007. It should be noted that producers have access to 2% liquid strychnine concentrate, thereby increasing the opportunity for off label use and stockpiling. Until July 2009, PMRA began to allow use of strychnine-laced grain by pest control operators, agricultural producers, and authorized personnel from government-approved pest control programs, in rural areas with high densities of Richardson's Ground Squirrel (PMRA 2008). In Alberta, the use of 2% strychnine for the same purpose was reinstated in 2009. Besides restrictions on use where species at risk are present, the only other safeguard against Swift Fox poisoning is product labelling.

Zinc phosphide has been used as a rodenticide in Alberta and Saskatchewan. It comes in a solid, granular or pellet form. Control of ground squirrels calls for placement of bait on the highest part of the mound, 15-20 cm from the burrow opening (PMRA 2006a). This makes baits accessible to Swift Foxes. Sodium cyanide is also used to control rodents in prairie agricultural areas. To protect Swift Foxes from accidental poisoning in Alberta, labels on sodium cyanide containers must now include a website address for a Swift Fox range map and notification that users must consult the Alberta Fish and Wildlife office in Medicine Hat for approval (PMRA 2006b).

During grasshopper outbreaks, landowners often increase application of insecticides. During such outbreaks, Swift Foxes consume a higher proportion of grasshoppers as part of their diet (Kilgore 1969; Egoscue 1979), which could lead to increased poisoning. For example, Sovada *et al.* (1998) reported that 22% (n=18) of dead radio-collared Swift Foxes in Kansas were poisoned by insecticide.

Vehicle collisions

Swift Foxes often den near roads (Hillman and Sharps 1978; Hines and Case 1991; Carbyn 1998; Pruss 1999) making them susceptible to vehicle collisions. Road kill is an important source of mortality, particularly for juveniles (Pruss 1994; Sovada *et al.* 1998; Herrero 2003; Kamler *et al.* 2003a; Ausband and Foresman 2007). Kits are especially vulnerable when dens are close to highways (Carbyn 1998). Of 89 Canadian Swift Fox carcasses (1983-1992), five were likely road kills (Carbyn *et al.* 1994). Within the last year or so, there have been at least five confirmed road-killed Swift Foxes in southeastern Alberta (J. Nicholson comm. 2009). Necropsies of 39 Swift Foxes from the border population confirmed three deaths due to vehicle collisions (Moehrenschlager *et al.* 2007b). In Montana, vehicle collisions caused 15% (n=33) of mortalities in radio-collared Swift Foxes (Ausband and Foresman 2007).

Recent expansion of the oil and gas industry on the Canadian prairies means increased road development, increasing the risk of road kill (Pruss *et al.* 2008). There is currently a proposal to open the Wild Horse US/Canada border crossing for 24-hour service and expand Highway 41 in southeastern Alberta (Fig. 6) as a north-south transportation corridor. This would certainly result in significant increases in traffic volume and 24-hour heavy truck traffic through one of the highest density Swift Fox areas in Alberta (Hildebrand 2008).

Interspecific competition

Interspecific competition, particularly with other canids may limit Swift Fox populations, particularly when mediated by habitat changes. Competitive interaction strength is likely related to prey abundance (Creel *et al.* 2001). Given that Coyotes seldom consume Swift Foxes after killing them is evidence for interference competition (Sovada *et al.* 1998; Kitchen *et al.* 1999; Matlack *et al.* 2000; Kamler *et al.* 2003b). The extirpation of Wolves (*Canis lupus*) on the Canadian prairies led to Coyote range expansion (Riley *et al.* 2004), raising the potential for negative impacts on Swift Fox populations.

Red fox have also recently expanded their range on the Canadian prairies, stimulated at least in part by habitat fragmentation and the expansion of the human footprint (Kamler and Ballard 2002). This relatively novel competitor with Swift Foxes may be even more significant than Coyotes because: 1) in rural areas, Coyotes typically avoid areas of high human activity (Roy and Dorrance 1985; Pruss 2002), whereas Red Foxes, like Swift Foxes, will associate with humans (Nowak 1999); 2) anthropogenic changes on native prairie, such as urbanization and fragmentation (particularly from oil and gas development), have facilitated Red Fox range expansion into Swift Fox range (Kamler and Ballard 2002); 3) while there is considerable dietary overlap between Swift Foxes and Coyotes (Kitchen *et al.* 1999; Kamler *et al.* 2007b), the overlap is even greater between sympatric foxes (Moehrenschlager and Sovada 2004); and 4) Red Foxes tend to occur at higher densities than Coyotes (Knowlton 1972; Baker and Harris 2004) meaning that encounter likelihood increases. The interaction between Coyotes and Red Foxes may affect the strength of competition between Red Foxes and Swift Foxes (Carbyn 1998; Allardyce and Sovada 2003; Cypher *et al.* 2003). In southern Colorado, Coyote population reduction temporarily increased survival rates of both juvenile and adult Swift Foxes, although effects on adults were highly dependent on the timing of coyote control (Karki *et al.* 2007). Robinson (1961) and Linhart and Robinson (1972) found no increase in Swift Foxes following Coyote control.

Trapping

Today, the endangered status of the Swift Fox in Canada affords the species legal protection from trapping, although incidental injuries or mortalities in traps or snares set for other species are known to occur (Moehrenschlager 2000). At one time, Swift Foxes were important for the North American fur trade, with 117,025 pelts traded between 1853 and 1877 (Herrero *et al.* 1986). However, trapping for Swift Fox dramatically declined as a result of declining populations and low pelt prices (US$3–10 [Stephens and Anderson 2005]).

SPECIAL SIGNIFICANCE OF THE SPECIES

As the smallest canid in North America and one of the fastest animals on the continent, Swift Foxes have considerable appeal. They are emblematic for the conservation of prairie ecosystems. Whether digging their own burrows or expanding those of other species, Swift Foxes are important for the natural disturbance regime of native short- and mixed-grass prairie ecosystems. Their diet, largely consisting of rodents and insects, should lead to favour with landowners, as well as being relatively benign with regard to livestock and crops.

In many First Nation cultures, Swift Foxes are significant. Swift, Kit, or Prairie Fox societies (e.g., the Kainai [Blood Tribe] Kit Fox Society) had unique apparel, haircuts, ceremonies, dances, customs, and accompaniments (Laubin 1977). The status of these societies was directly related to the Tribe's image of the value and character of the fox (see Pruss *et al.* 2008). Swift Foxes have been regarded as being powerful, too dangerous even to speak of, and with the strongest medicine (Wissler and Duvall 1995). In southern Alberta, Blood Tribe elders recognize that the Sinopaa (Swift Fox) plays a vital role in Kainai spirituality, and there exists considerable interest in continuing Swift Fox reintroductions on Blood Tribe lands (Pruss *et al.* 2008).

Attempts to gather Aboriginal Traditional Knowledge on Swift Fox to inform this status report were not successful.

EXISTING PROTECTION OR OTHER STATUS DESIGNATIONS

Swift Foxes were designated as Extirpated by COSEWIC in 1978. They were re-assessed as Endangered in May 2000 after initial reintroduction success (COSEWIC 2000). Swift Foxes are protected under Schedule 1 of the *Species at Risk Act* (SARA; SARA Public Registry 2008). The *IUCN Red List of Threatened Species* ranking for Swift Foxes is Least Concern (IUCN 2008b). NatureServe (2008) ranks Swift Foxes globally as G3 (Vulnerable; last reviewed June 2006) and nationally as N1 (Endangered). Both the Alberta Natural Heritage Information Centre (ANHIC) and the Saskatchewan Conservation Data Centre (SCDC) have designated the Swift Fox as S1 (Critically Imperilled; ANHIC 2008; SCDC 2008).

The Swift Fox is listed as endangered under the *Alberta Wildlife Act*, which confers protection of individuals through prohibitions on hunting and trapping, as well as the den site. The legislation does not protect habitat apart from the den. This is accomplished through land use guidelines, which are government policy and not based in legislation. These constitute the recommended management practices to "assist land managers, land owners and land users in avoiding or minimizing potential adverse impacts to wildlife from various land use activities." The guidelines for Swift Fox suggest that all levels of land use activity should be prohibited within 500 m of a den (Alberta Fish and Wildlife 2001) during breeding and kit-rearing season (15 February to 31 July). Outside this period, the guidelines provide advice for approaching dens, disturbing vegetation and incurring long-term habitat changes (Alberta Fish and Wildlife 2001).

In 1999, Swift Foxes were classified as Endangered under the *Wild Species at Risk Regulations* of the *Saskatchewan Wildlife Act*. This protects Swift Fox dens (Section 5(1)) and prohibits killing by landowners to protect property or livestock (Section 6(3)). Provincial guidelines also recommend no disturbance activity around dens. During the breeding and kit-rearing period (15 February to 31 August), low (e.g., foot traffic, small vehicles) and medium (e.g., large vehicles, small pipeline construction, operation of compressor stations) disturbances are prohibited within 500 m, whereas high levels of disturbance activity (e.g., construction, seismic exploration, forest harvest) are not permitted within 2 km (SCDC 2003). During the rest of the year, the setback distances from Swift Fox dens are 100 m, 500 m, and 2 km for low, medium, and high levels of disturbance activity, respectively (SCDC 2003).

Most of Swift Fox range in Canada is unprotected. Because Critical Habitat has not been identified, there is no habitat protection for Swift Foxes under SARA under Section 58(1) at this time. About one-sixth of the Canadian Swift Fox population resides within the boundaries of Grasslands National Park (Moehrenschlager and Sovada 2004), making them federally protected. For the Border population, 40% (38 of 84) of all captures and 73% (38 of 52) of Saskatchewan captures were in townships containing PFRA lands (Moehrenschlager and Moehrenschlager 2006). Ninety percent (18 of 20) of the Swift Fox captures in the GNP population were in townships with PFRA and/or Parks Canada lands. Energy development activities have, however, been able to proceed on some PFRA lands.

In the US, Swift Foxes were petitioned for listing under the *Endangered Species Act*; however, in 2001 the US Fish and Wildlife Service (USFWS) decided the listing was unwarranted (USFWS 2001). Swift Foxes are legally protected in 10 US states. Once considered extirpated in North Dakota, recent sightings have prompted the North Dakota Fish and Game Department to list Swift Foxes as a Level II Species of Conservation Priority (Fecske 2008).

TECHNICAL SUMMARY

Vulpes velox
Swift Fox Renard véloce
Range of occurrence in Canada (province/territory/ocean): Alberta, Saskatchewan

Demographic Information

Generation time	At least 3 yrs
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	No
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	The number has remained stable over the last 5 yrs
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations].	There has been a 126% increase over the last 10 yrs
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	Unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future.	Stable-increase
Are the causes of the decline clearly reversible and understood and ceased?	No
Are there extreme fluctuations in number of mature individuals?	No

Extent and Occupancy Information

Estimated extent of occurrence	21,544 km²
Index of area of occupancy (IAO) Moehrenschlager and Moehrenschlager (2006) used townships rather than 2x2 grid to calculate AO.	6,343 km²
Is the total population severely fragmented?	No
Number of "locations*" For Swift Fox in Canada, disease is a "single threatening event" that can rapidly affect all individuals of the taxon present. This threat is real for Swift fox because: 1) high recorded seroprevalence of several viruses in the current population, 2) documented evidence of unpredictable disease outbreaks driving the near extirpation of many endangered canid populations worldwide, and 3) Swift Fox in Canada exist as one meta-population with evidence of long-range dispersal between sub-populations, and therefore one epidemiological unit. This meets the IUCN definition of 1 location.	1
Is there an [observed, inferred, or projected] continuing decline in extent of occurrence?	No
Is there an [observed, inferred, or projected] continuing decline in index of area of occupancy?	No
Is there an [observed, inferred, or projected] continuing decline in number of populations?	No
Is there an [observed, inferred, or projected] continuing decline in number of locations?	No
Is there an [observed, inferred, or projected] continuing decline in [area, extent and/or quality] of habitat?	Yes, although extent of impact is unknown
Are there extreme fluctuations in number of populations?	No
Are there extreme fluctuations in number of locations*?	No

* See definition of location.

Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

Number of Mature Individuals (in each population)

Population	N Mature Individuals
Border (Alberta, Saskatchewan) (general approximation – mature proportion unknown)	513 (estimated)
GNP (Saskatchewan) (general approximation – mature proportion unknown)	134 (estimated)
Total	647

Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years].	N/A

Threats (actual or imminent, to populations or habitats)

- Predation (Coyotes)
- Habitat alteration (conversion to agriculture, energy development, roads, climate change)
- Disease
- Poisoning
- Trapping
- Road mortality
- Interspecific competition (Coyotes, Red Foxes)

Rescue Effect (immigration from outside Canada)

Status of outside population(s)? Montana (USA): Vulnerable; population is increasing	
Is immigration known or possible?	Yes
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada?	Yes
Is rescue from outside populations likely? Rescue is likely from Montana only, but not from core Swift Fox range in the U.S.	to a limited extent

Current Status

COSEWIC: Threatened (November 2009)
Alberta: Endangered
Saskatchewan: Endangered
IUCN Red List of Threatened Species: Least Concern

Status and Reasons for Designation

Status:	**Alpha-numeric code:**
Threatened	D1+2
Reasons for designation: This species was extirpated from Canada in the 1930s. Following reintroduction programs in Alberta and Saskatchewan initiated in 1983, they have re-established populations in these areas and in northern Montana. Population numbers and distribution have increased since that time, with the current estimate in Canada having doubled to 647 since the last COSEWIC assessment in 2000. Connectivity between populations has also improved during this time, particularly through northern Montana. Since 2001, population numbers and distribution have remained stable and habitat for this species within Canada appears to be saturated. Most improvement in overall population status can be attributed to populations in Montana, which are still demonstrating increasing trends in numbers and distribution. Deteriorating habitat in Canada and the threat of disease (as seen in other canids) could threaten the continued recovery of this species.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. The current Canadian population(s) increased after reintroductions. There is no indication that the total number of mature individuals has declined over the last 10 years/3 generations, or might do so in the next 10 years/3 generations.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. While the extent of occurrence hovers at about the threshold for Threatened under criterion B1 (21,544 km²), there is no clear fit for the accompanying conditions that must be met. Swift Fox population(s) in Canada do not undergo extreme fluctuations and although there is continued habitat decline in the region, the extent to which this is having or will have an impact on current Swift Fox range and population status is unknown.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. There is no indication of a declining number of mature individuals
Criterion D (Very Small Population or Restricted Distribution): Meets Threatened D1+2. D1: current population estimate for mature individuals for Swift Fox is 647, which places it well above 250 (Endangered) but below the 1000 threshold for Threatened. D2: Swift Fox in Canada are in one connected location, and subject to the possibility of one threatening event, disease, affecting all members of the species. They therefore qualify as Threatened under this criterion.
Criterion E (Quantitative Analysis): Not applicable. There is no population projection suggesting that the probability of extinction of the species in the wild is > 10% (100 yrs) or > 20% (20 years/5 generations).

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